



US LHC Accelerator Project - BNL

Superconducting
Magnet Division

Magnet Production
Magnet Performance
Cable testing
Cost & Schedule
Summary

BNL LHC Magnet Production Status



Superconducting
Magnet Division

- D1 - 5 complete, 4 shipped, 1 in retest with a soft short to ground in one heater.
- D2: 7 of 9 tested, 4 QQS' complete, first magnet accepted by CERN
- D4 - 2 complete, remaining cold mass complete
- D3 cold masses - shells, end plates welded, E/M complete, end volumes started
- Design effort complete, except:
 - D3 changes requested by CERN to anchor He pipes at LE
 - D1 interconnect to DFBX in design (on hold awaiting design support)
- Issues since last time:
 - Revision of He pipe anchors to LE
 - Lateral bow measured at CERN in D1 beam tubes/magnets - request for additional measurements in remaining magnets

D2 QQS Work Underway



**Superconducting
Magnet Division**



2
completed
magnets
(note both
LH and RH
versions)

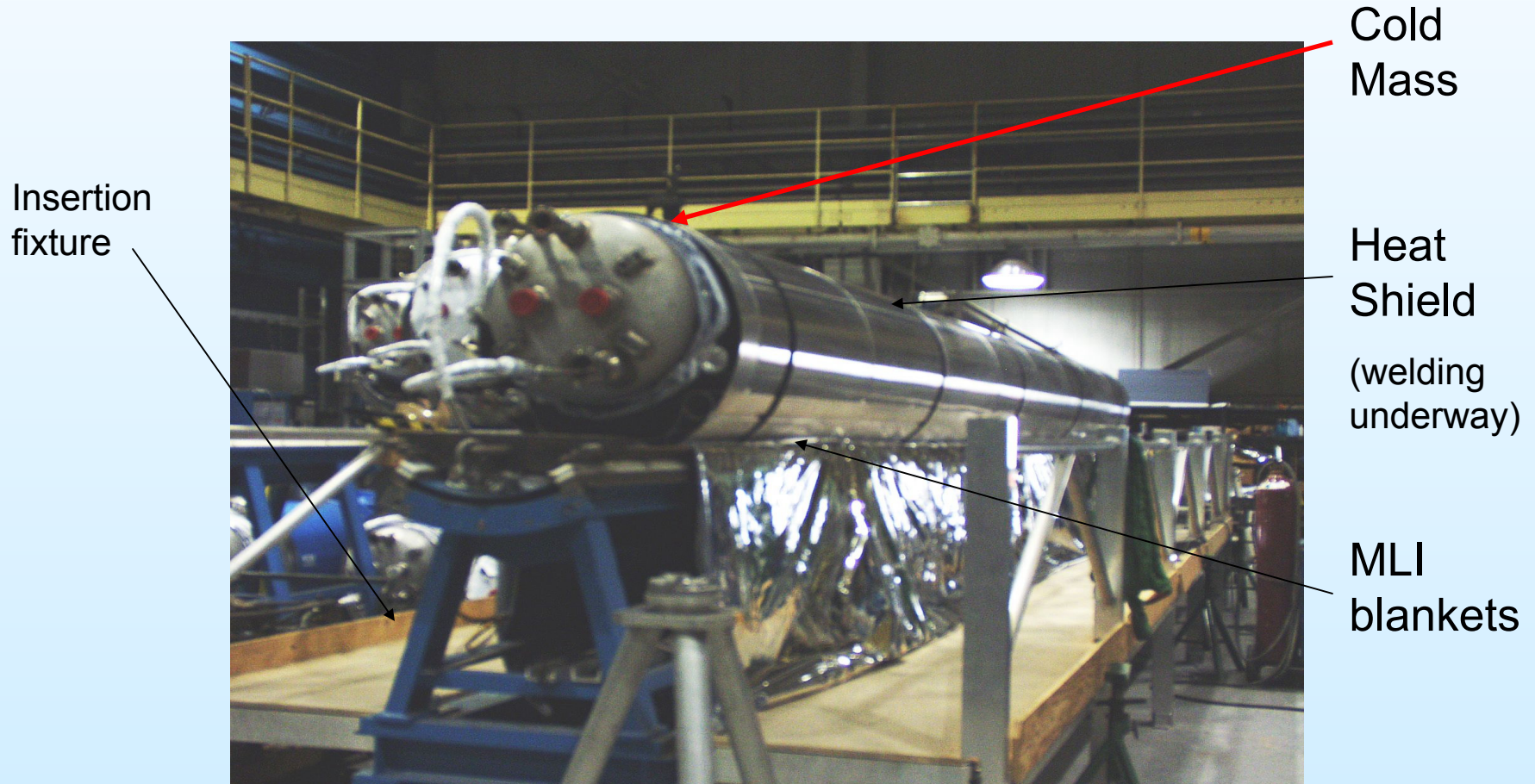
D2L102
in
process



D4L102 Cold Mass Build-up (Cryostat Assembly)



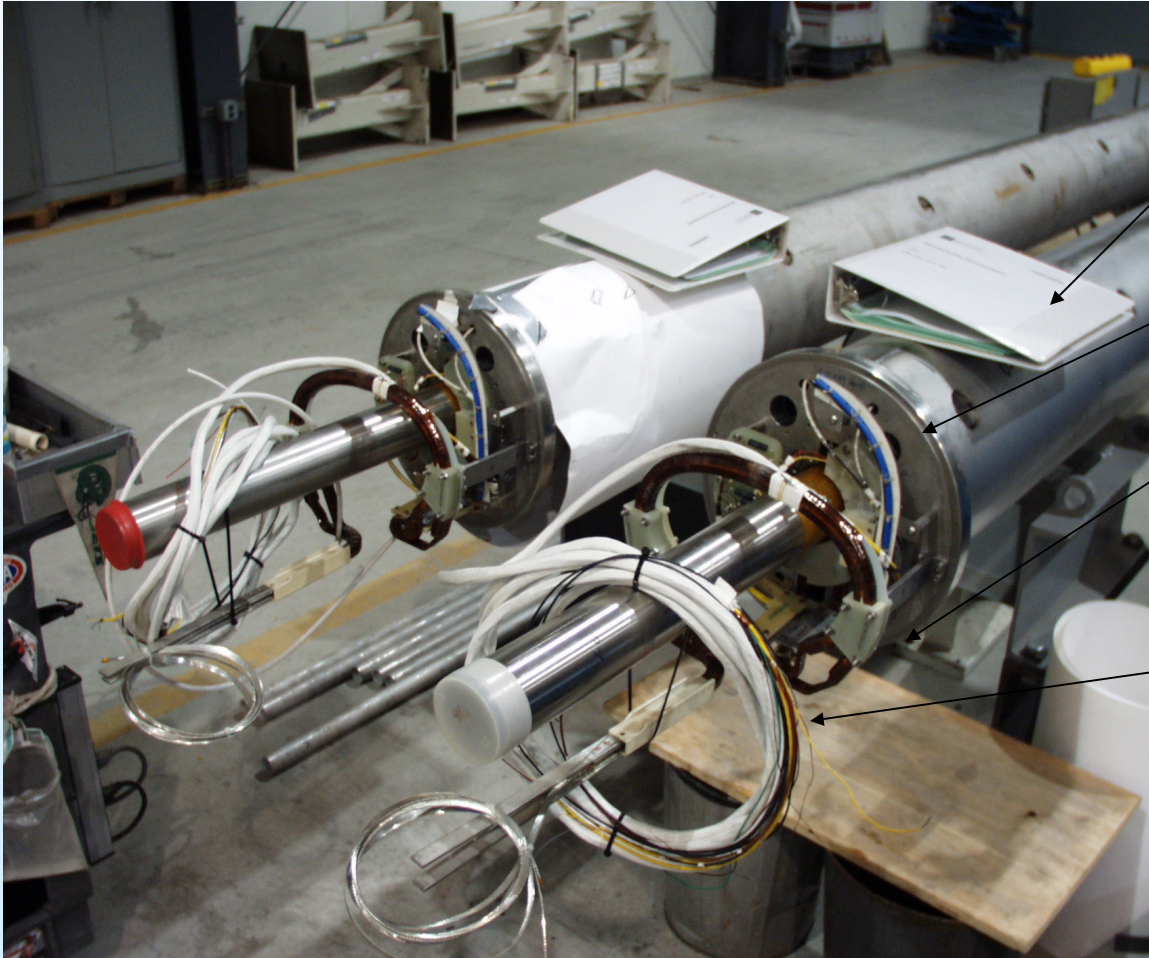
Superconducting
Magnet Division



D3 Cold Mass Electro/Mechanical Assembly



Superconducting
Magnet Division



(Superb
documentation)

Level probes

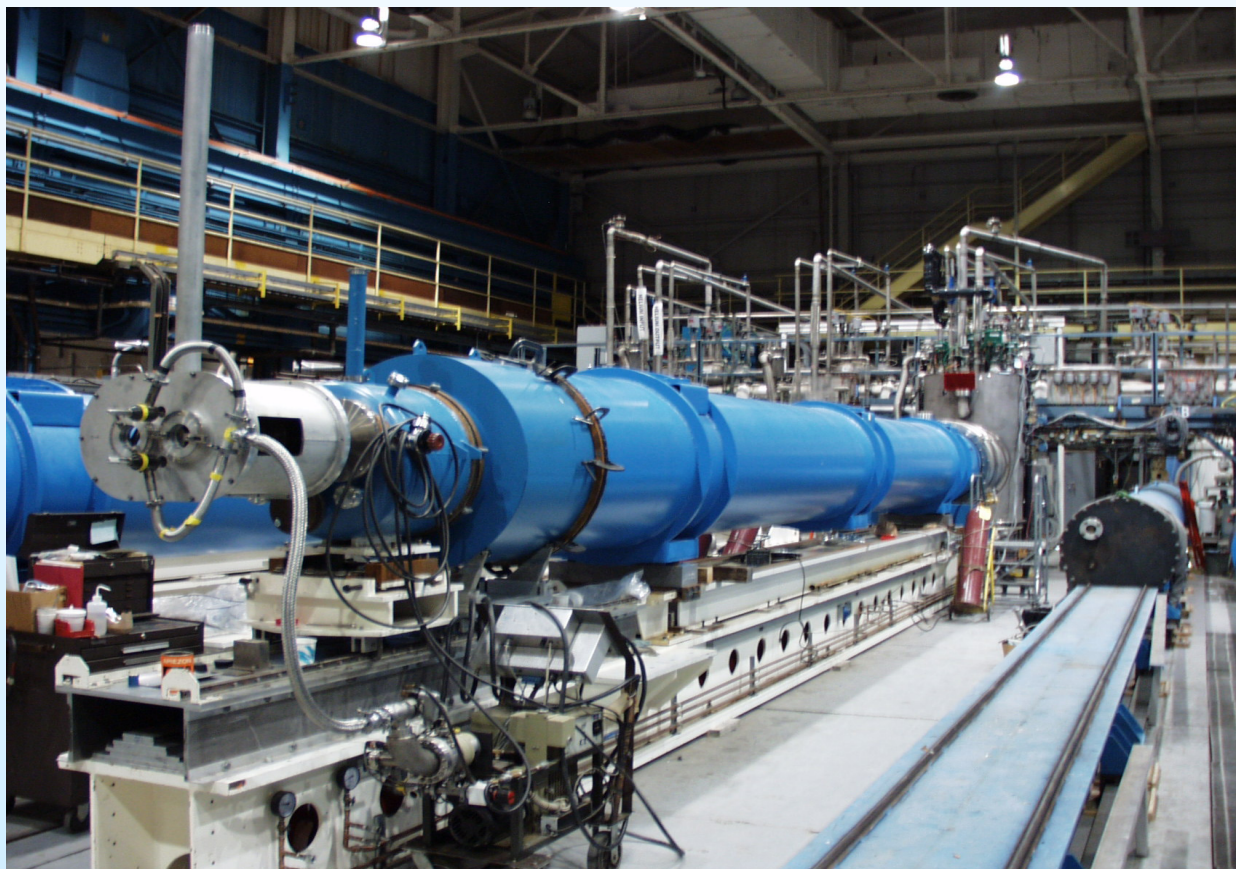
Expansion
joint

IFS
instrumentation
wire bundle

D2L108 Installed in MagCool Test Bay



Superconducting
Magnet Division



BNL LHC Magnet Production Status (cont'd)



Superconducting
Magnet Division

Remaining Schedule

- Production

- D4 complete by the end of October
- D3 complete by the end of December
- D2 QQS complete 2/04
- Shipping into early FY05

- Testing

- Last magnet completed in June 04
- SC testing through March 05



Magnet Measuring

Superconducting
Magnet Division

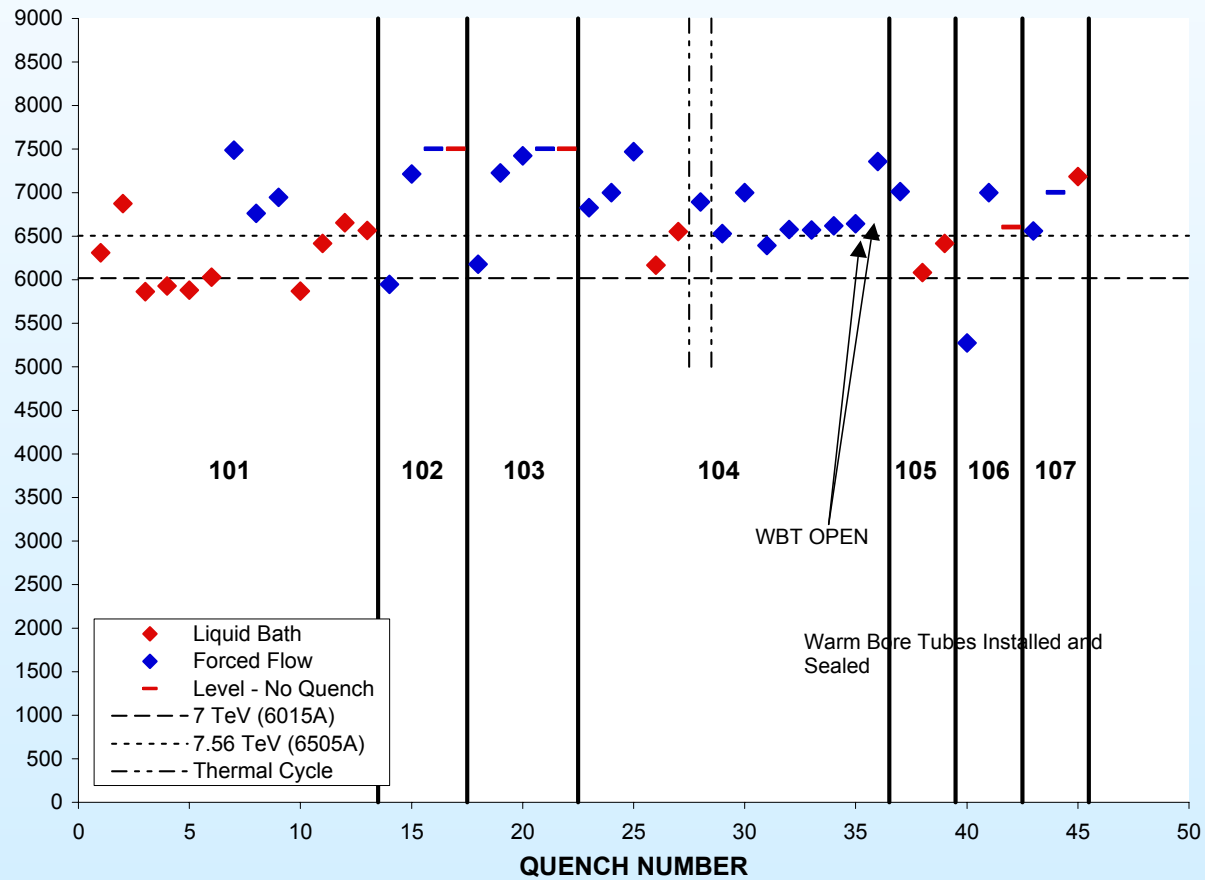
- All D1 dipoles measured and 4 accepted. Some questions raised by CERN about straightness (based on bore tube data). D1 #5 will re-measured and quench tested.
- Warm measurements are complete on all 9 D2's. 7 D2's have been cold tested and 4 with field measurements. Warm cold correlations established. One D2 has been accepted by CERN, possibly more importantly, the protocol has been established.



D2 Cold testing

Superconducting
Magnet Division

D2 QUENCH TESTS

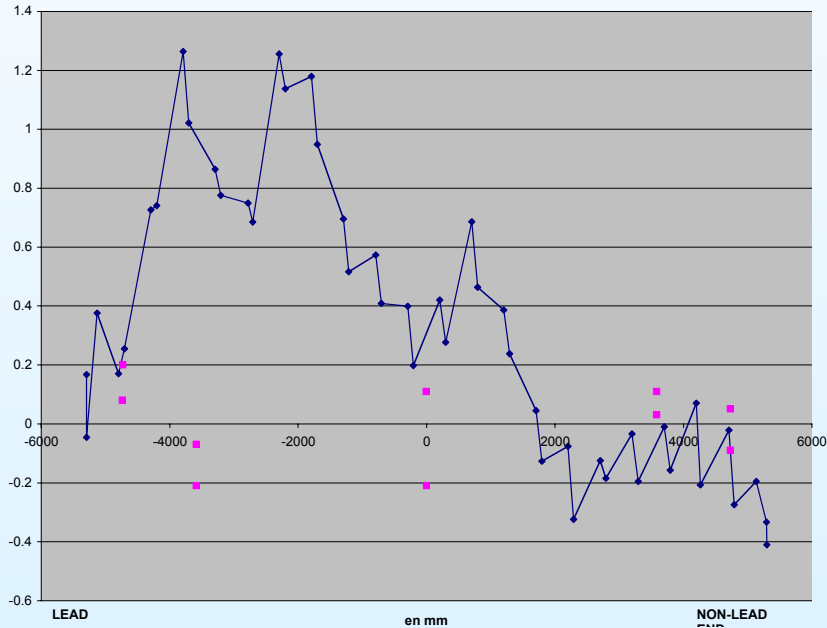


D1-102 CERN Survey

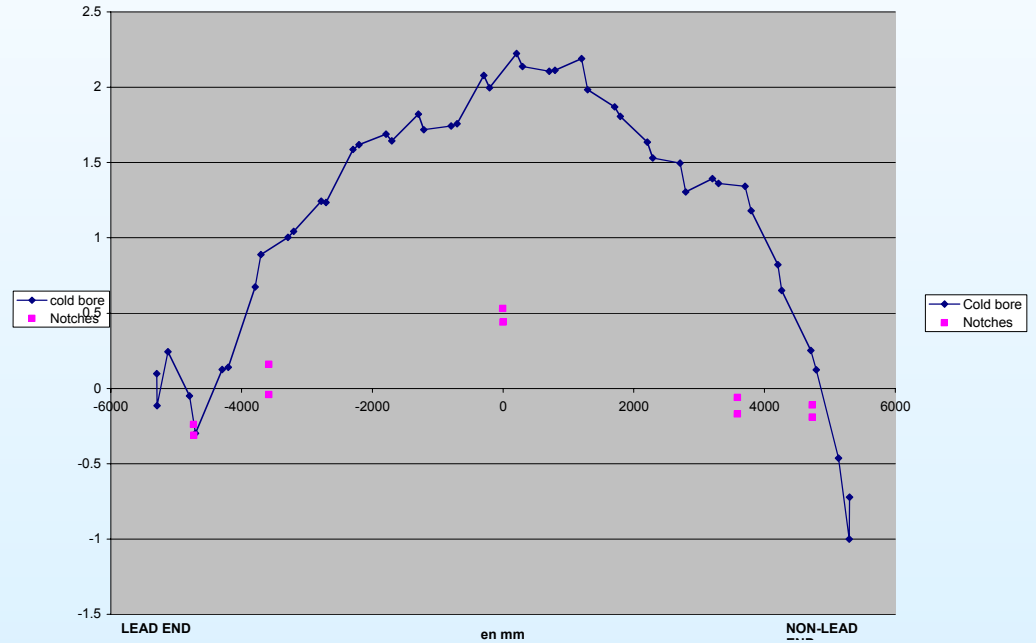


**Superconducting
Magnet Division**

D1L102 - Vertical shape



D1L102 - Horizontal shape



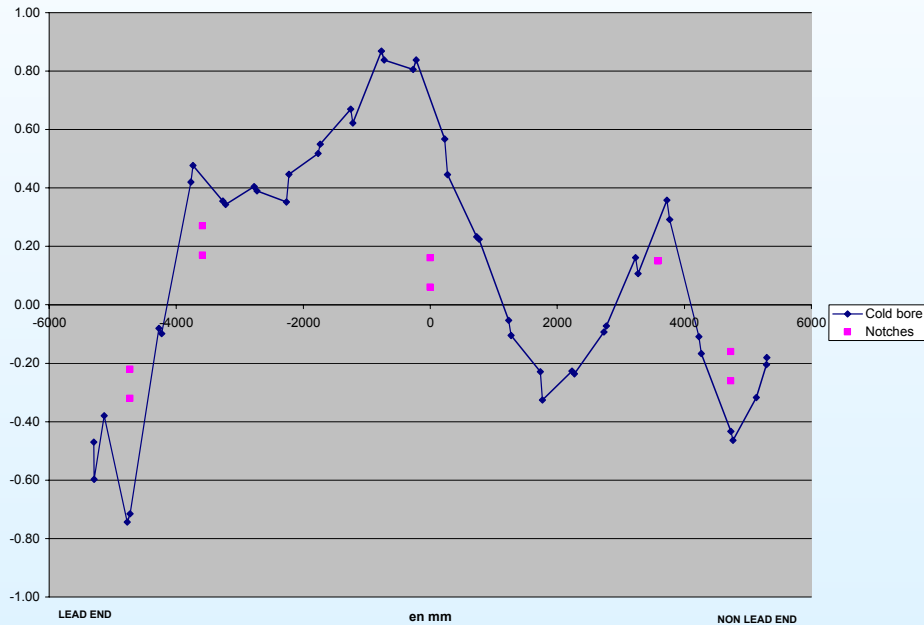
- CERN bore tube measurements v's BNL cold mass survey

D1-104 CERN Survey

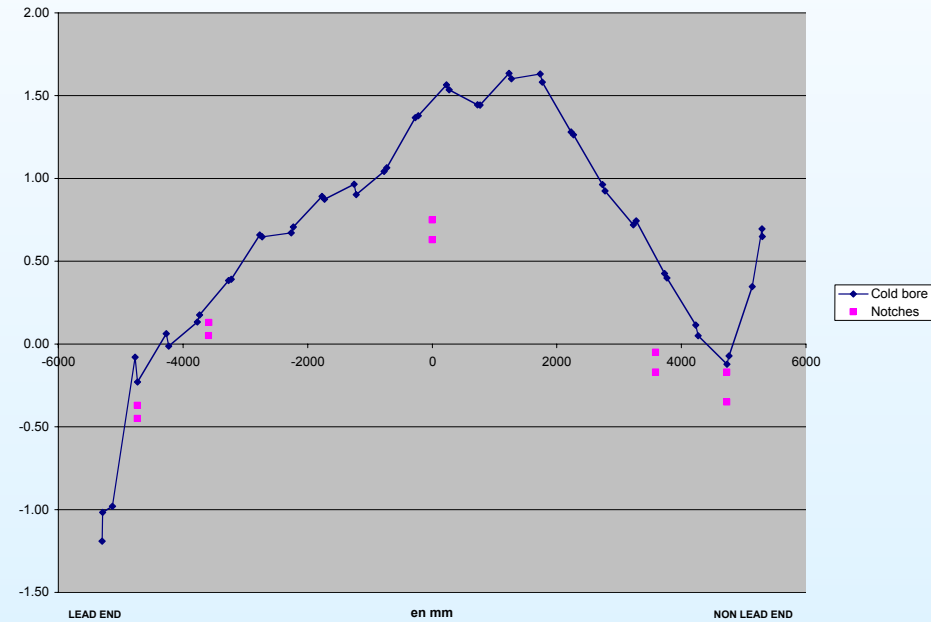


**Superconducting
Magnet Division**

D1L104 - Vertical shape



D1L104 - Horizontal shape



- CERN bore tube measurements v's BNL cold mass survey
Some form of systematic effect ?

LHC Superconductor support: Cable Test Facility



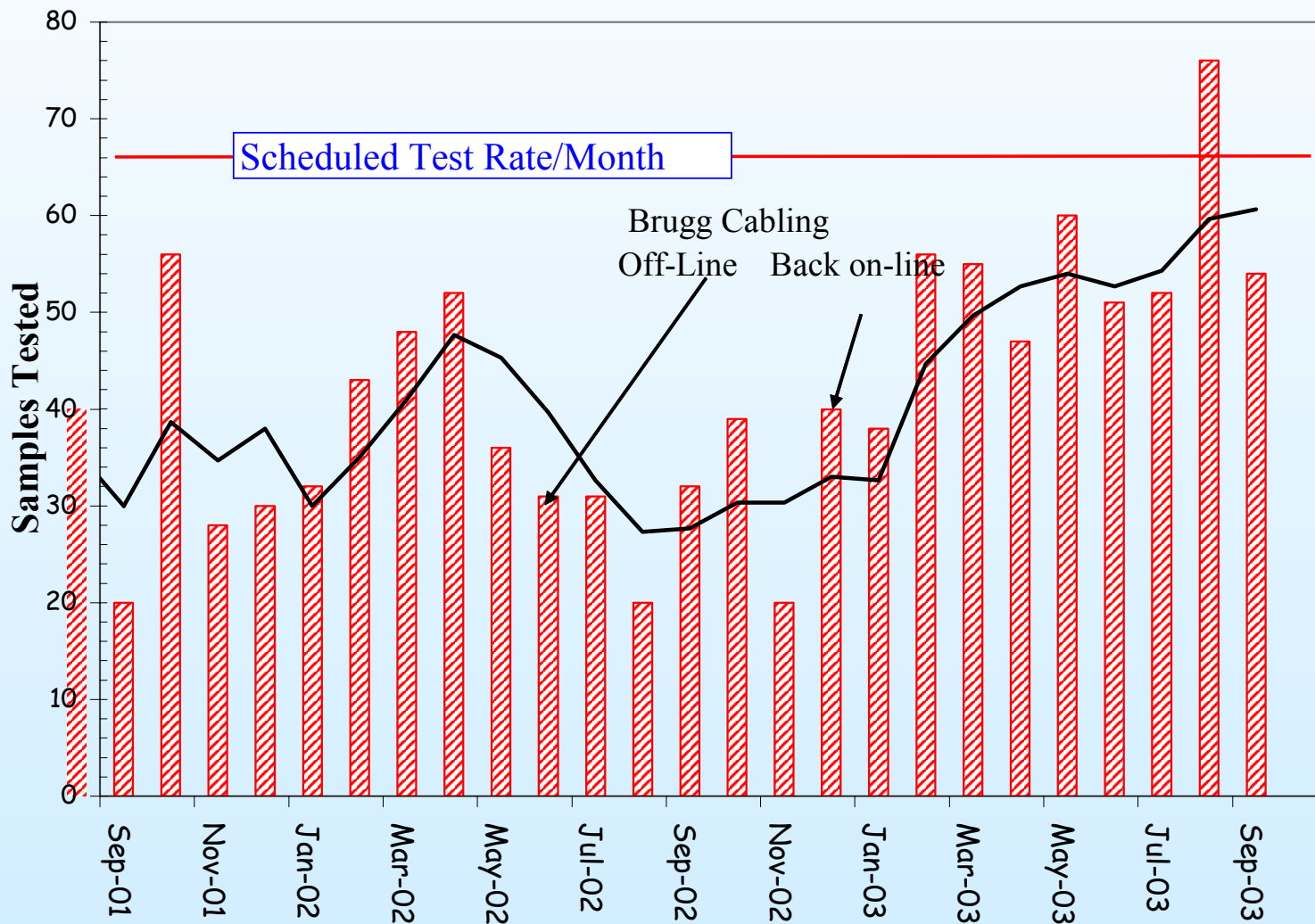
**Superconducting
Magnet Division**

- Three test stations are in continuous operation.
- Production schedule is delayed by ~ 6-12 months.
 - Completion of cable production expected by Sep-30-05
 - 01 Cable delivered 39%
 - 02 Cable delivered 41%
 - MQM/MQY cable delivered ~ 10%
- Cable production is approaching peak rate
 - Brugg Cabling machine not at plateau rate
 - Furukawa has completed its octant
 - Furukawa producing second octant of 02-cable (Alstom producing only 2 octants of 02)
- 1505 samples tested (represents 44% of 3430 samples)
- Except for a few cases, samples tested so far have met minimum electrical requirements.
- 5 cabling machines are in operation. Cabling quality varies between different manufacturers as evidenced by Electrical measurements.



LHC Superconductor support: Samples Tested / Month

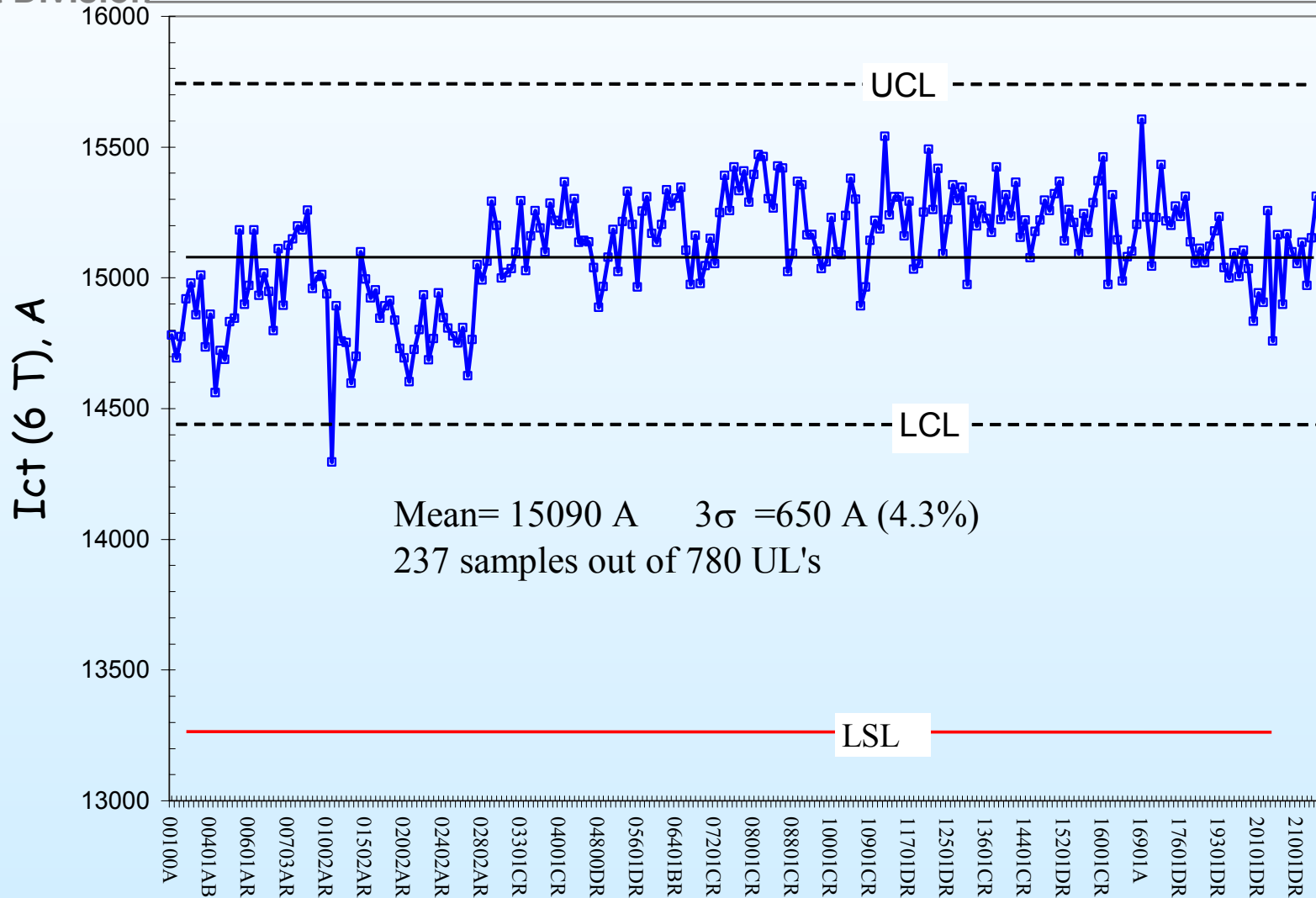
**Superconducting
Magnet Division**



LHC Superconductor support: Example of Tracking Cable Production 02 cable- one octant



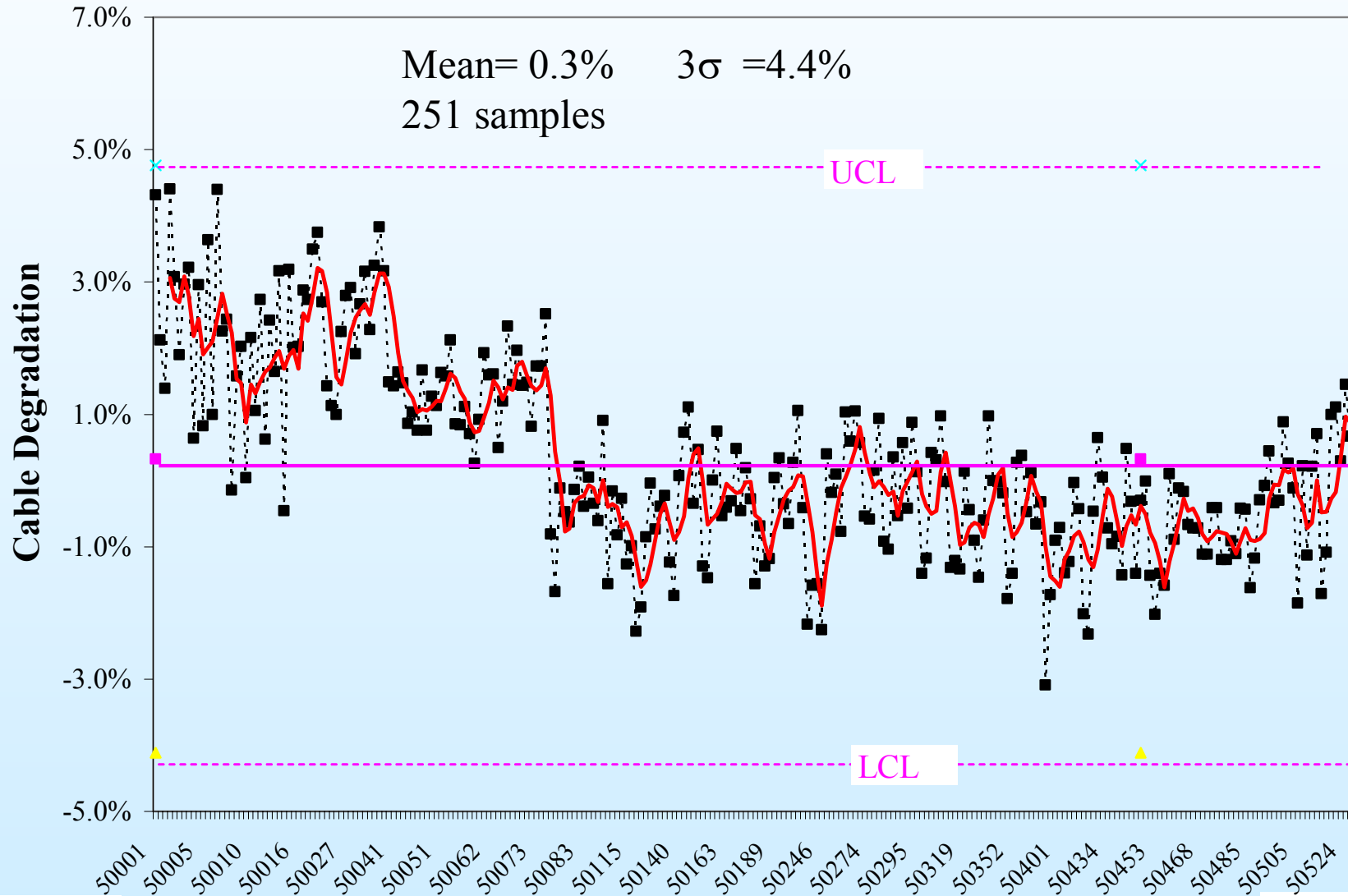
Superconducting
Magnet Division



LHC Superconductor support: 02-Cable Cabling Machine-2



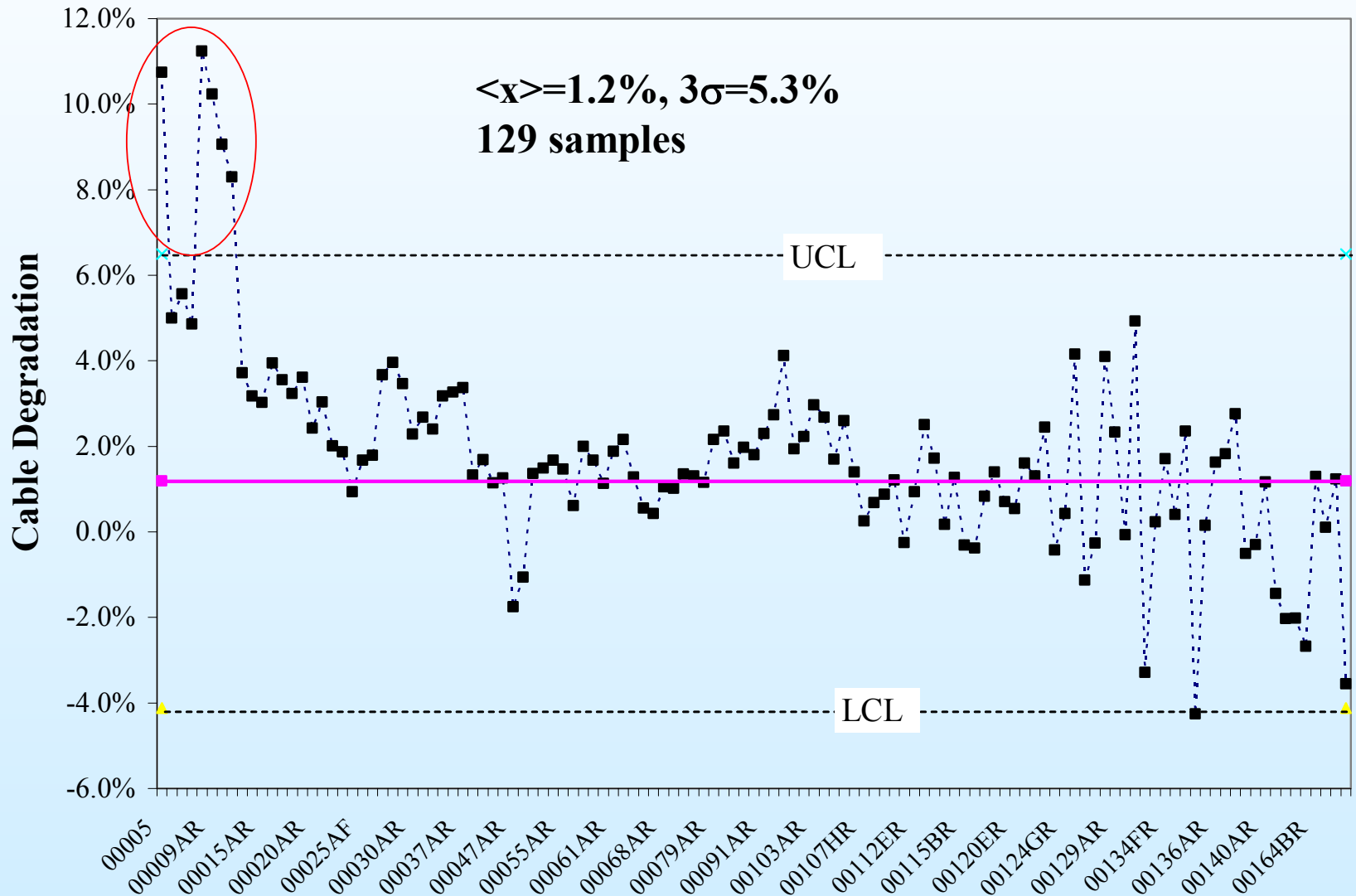
**Superconducting
Magnet Division**



LHC Superconductor support: 02-Cable Cabling Machine-3



**Superconducting
Magnet Division**





LHC Superconductor support:

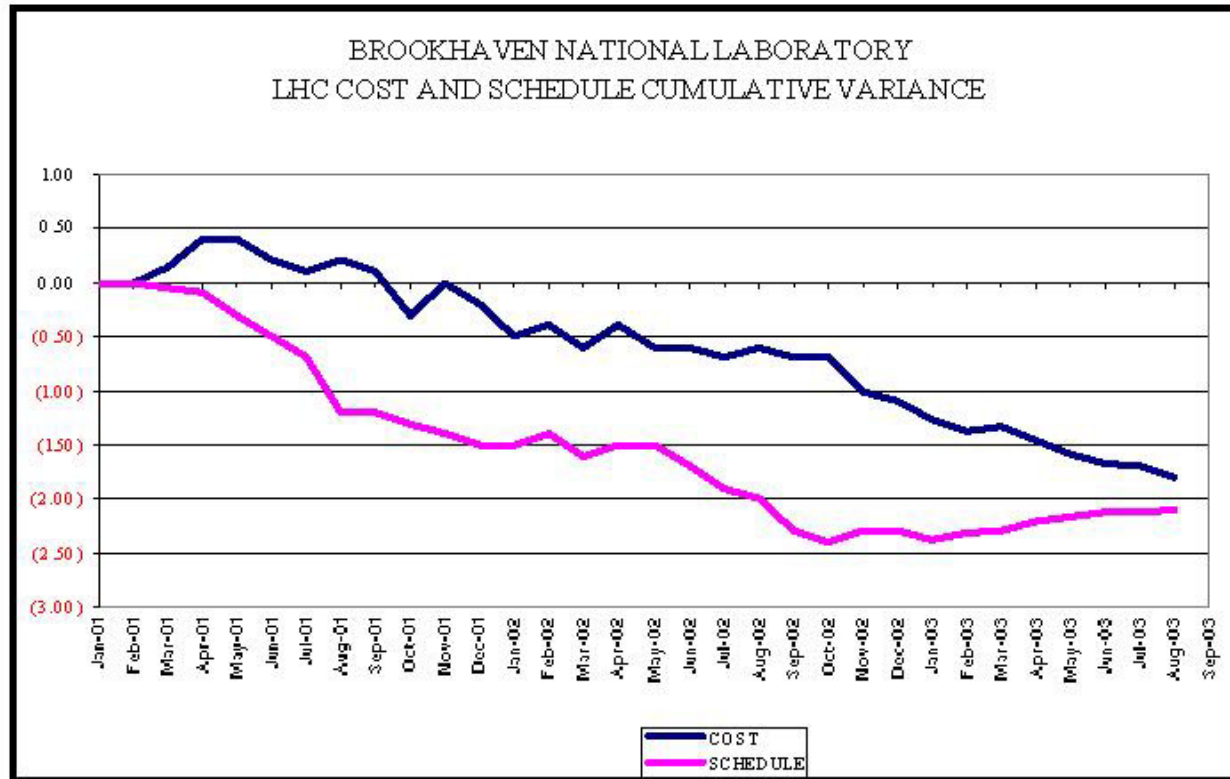
**Superconducting
Magnet Division**

- Have been assisting CERN staff in the oversight of the conductor procurement from OK-AS, Waterbury.
 - ⇒ By frequent plant visits, and communicating with people at Waterbury and at CERN.
 - ⇒ This contract will come to a close in March'04
- Have stayed intellectually involved with the strand and cable procurement, and have helped CERN staff in
 - ⇒ evaluating conductor performance
 - ⇒ reviewing production problems and remedies



The Problem: Cost variance

**Superconducting
Magnet Division**

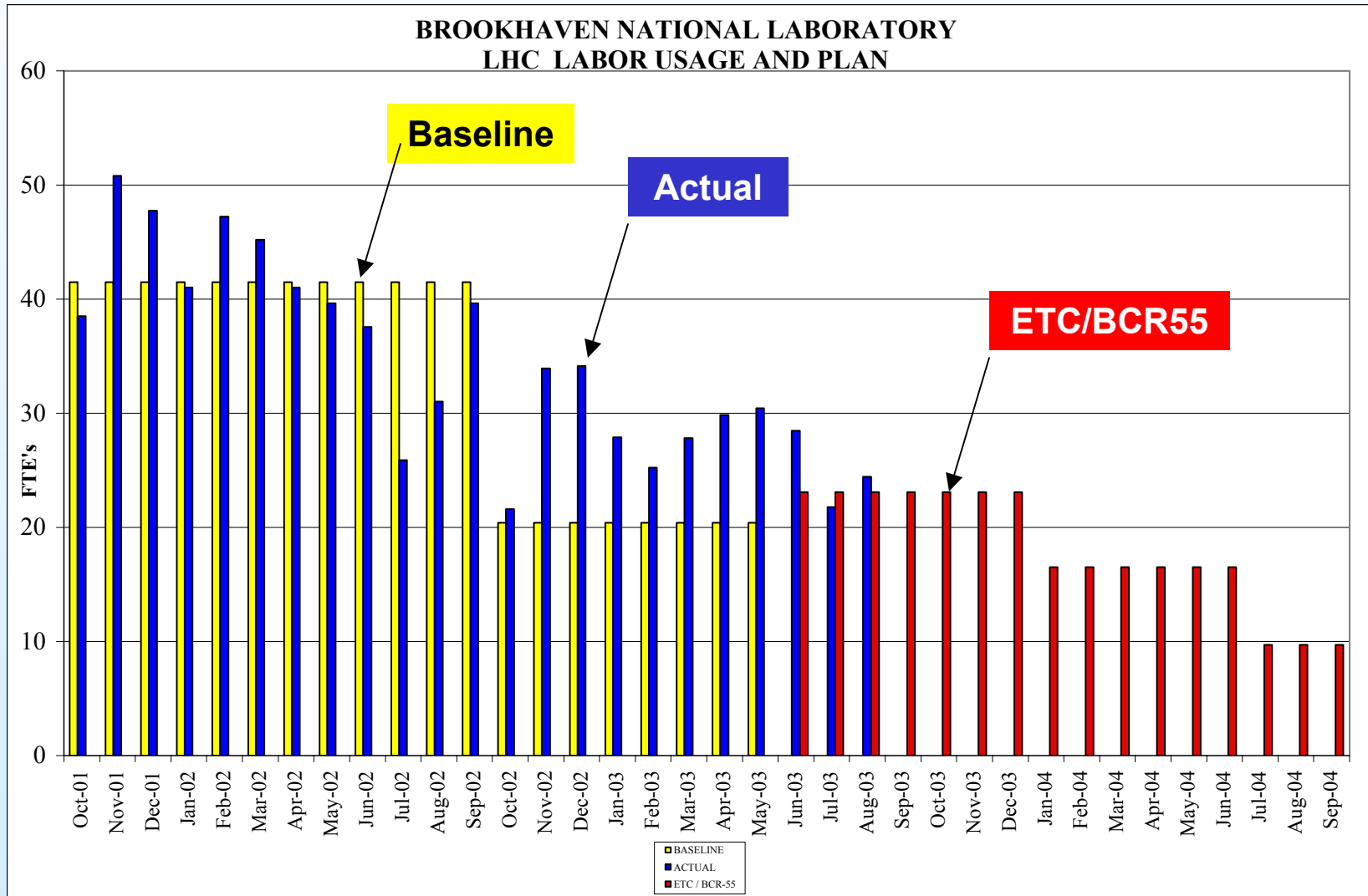


Variance of ~\$1.8M represents about 10% of total expenditure during this period



Manpower Projected v's Actuals

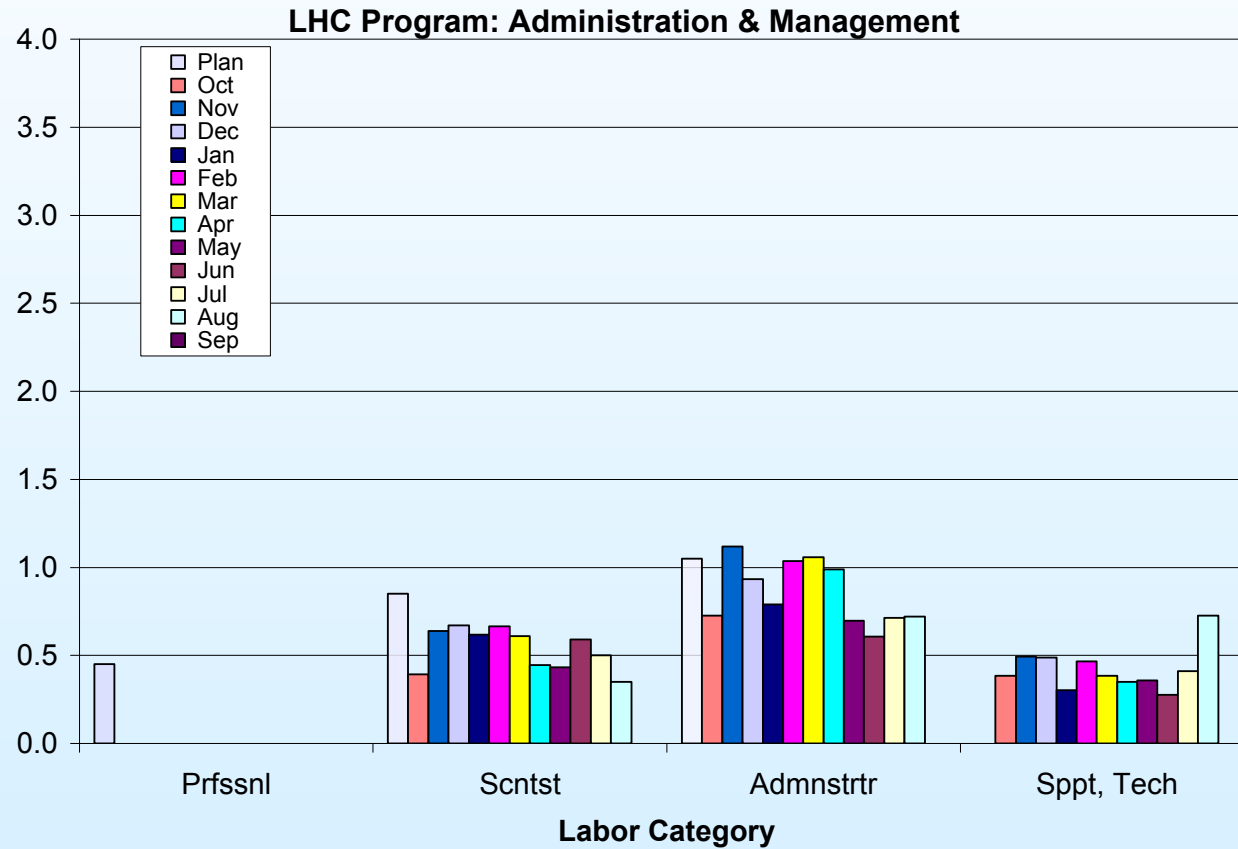
**Superconducting
Magnet Division**



FY03 manpower



**Superconducting
Magnet Division**



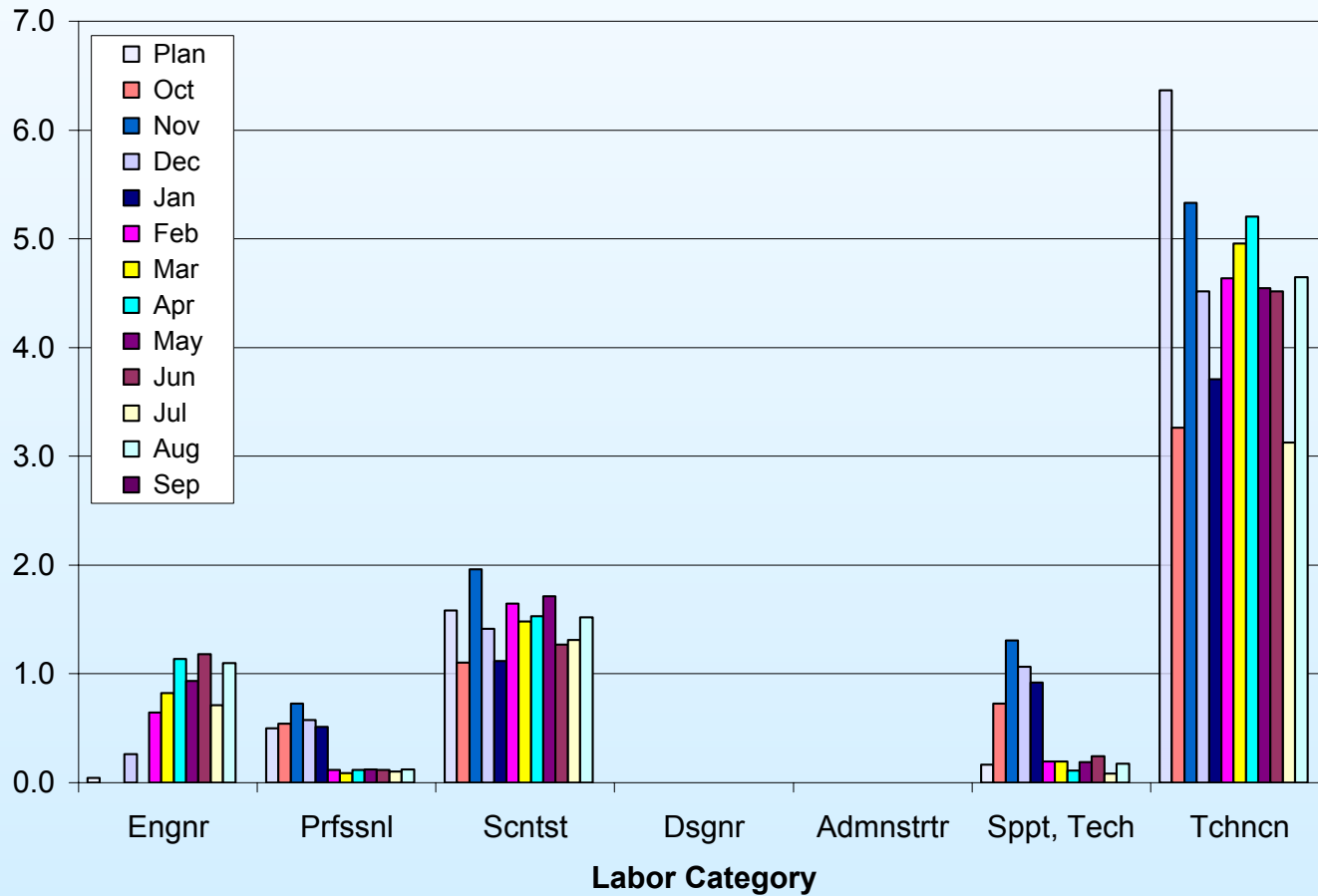
Under control

FY03 manpower



**Superconducting
Magnet Division**

LHC Program: SC Testing



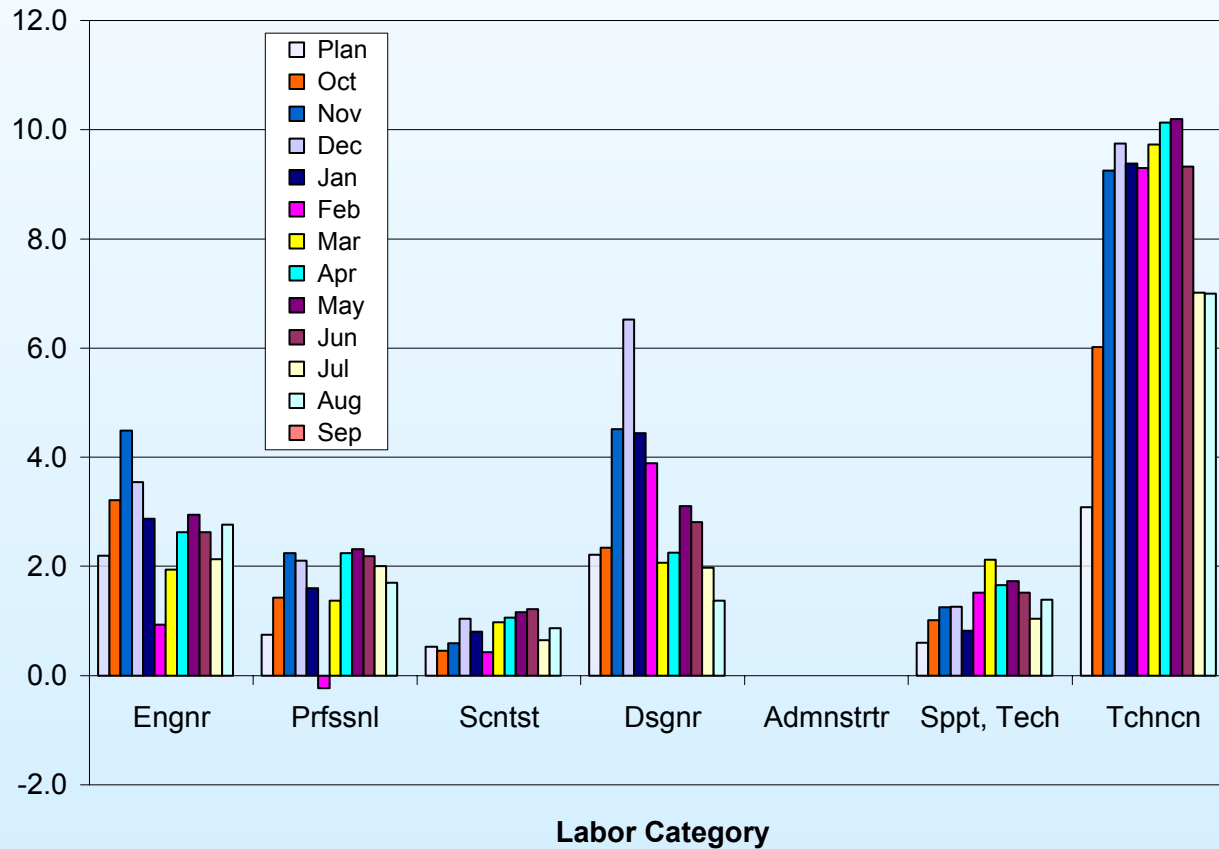
Sc Testing manpower slightly less than baseline

FY03 Manpower



**Superconducting
Magnet Division**

LHC Program: Magnets



Too much EDIA & design/technicians

Unit Costs are not helping



**Superconducting
Magnet Division**

LHC BASELINE					
DESCRIPTION	FY01 RATES	LHC FY03 Escalated Rates	AM Division Actual FY03 Rates	LHC PROJECTED vs. ACTUAL	% DELTA
SUPPORT ADMIN	\$36.25	\$38.27	\$46.49	(\$8.22)	-21.5%
DESIGNER	\$49.07	\$51.80	\$52.34	(\$0.54)	-1.0%
ENGINEERS	\$70.32	\$74.24	\$76.05	(\$1.81)	-2.4%
PROFESSIONAL	\$60.93	\$64.32	\$58.74	\$5.59	8.7%
SCIENTIST, MAGNETS	\$83.08	\$87.71	\$96.88	(\$9.18)	-10.5%
SCIENTIST, SC	\$74.62	\$78.78	\$87.71	(\$8.93)	-11.3%
SUPPORT TECHNICAL	\$37.98	\$40.10	\$44.17	(\$4.08)	-10.2%
TECHNICIANS	\$42.66	\$45.04	\$47.52	(\$2.49)	-5.5%
SC TECHNICIANS	\$41.31	\$43.61	\$48.00	(\$4.39)	-10.1%
CENTRAL SHOPS	\$77.75	\$82.08	\$87.00	(\$4.92)	-6.0%
BUILDING TRADES	\$64.90	\$68.51	\$70.90	(\$2.39)	-3.5%

FY01 LABOR COSTS	
DESCRIPTION	COST
PROFESSIONAL	\$962,375
SCIENTIST	\$689,852
TECHNICIAN	\$2,813,818
ADMINISTRATIVE	\$149,044
TOTAL FY01 LABOR COST:	\$4,615,089

FY03 LABOR COSTS Through August	
DESCRIPTION	COST
PROFESSIONAL	\$744,118
SCIENTIST	\$295,675
TECHNICIAN	\$1,347,469
ADMINISTRATIVE	\$94,207
YTD FY03 LABOR COST:	\$2,481,469

Variance Analysis - direct costs only



**Superconducting
Magnet Division**

- **SC Testing**
 - Total costs since Jan 01 \$2636K, variance -\$140K (-5.3%) in spite of lower sample rate/higher unit costs. We have been reasonably successful to date in flexible manpower usage. This is becoming more difficult as the overall program contracts but this is balanced by the increased cable production rate.
 - Costs are well behaved, well understood, and predictable. This augers well for the future.
 - Will treat as level-of-effort task in new baseline (BCR 55).
- **Program Management**
 - Total costs since Jan 01 \$1434K, variance -\$74K (-5.1%).
 - Costs are well behaved, well understood, and predictable.
- **Materials costs/testing**
 - Materials costs since Jan 01 \$9405K, variance -\$224K (-7.7%). Materials procurement is essentially complete but this variance arises from additional helium usage/testing hardware \$235K. Source of concern !

Variance Analysis - direct costs only



**Superconducting
Magnet Division**

- **Manpower**
 - **Manpower costs since Jan 01 \$6617K, variance -\$1168K (-17.6%). This is the dominant source of the variance to date.**
 - **Bad news:**
 - Magnet testing (variance -\$464K, 55% !!) continues until June 04. Under perfect conditions then we can test at the baseline rate. However life is generally less than perfect: refrigerator decontamination last week, roof repair (estimated 2 weeks down) at the end of October. Both require additional refrigerator cooldown cycles at best. Minor problems are amplified by the week-ends. Oil contamination early in FY03 was a major impact
 - Magnet acceptance continues to involve more work than anticipated
 - **Good news:**
 - Magnet production (variance -\$530K, -30%) is complete in a few months, but the variances on D3 & D4 have been small.
 - Magnet testing has been proceeding more smoothly (less badly ??) recently (105, 106, 107)



BCR 55 (direct costs only)

Superconducting
Magnet Division

Codifies an increase in "Variance at completion" from \$1334K to \$1660K:

Production labor variance by \$700K (~190K to go)

Testing labor variance by \$480K (~60K to go)

Testing materials variance ~\$250K (~\$20K to go)

EDIA reduction of \$250K in Project Management
and SC testing

Small scope changes in testing, design, + some
interface parts ~\$100K.



Summary

Technical performance of the magnets is O.K.

The end of production is in sight, the remaining challenge is to get the magnets shipped in a timely fashion (acceptance). Not too much concern (yet).

Technical interfacing issues seem to be getting solved with CERN in a professional fashion. Mutual problem solving is good. Sometimes this results in minor scope changes to the US effort as the most efficient solution.

Long magnet testing cycles (1-2 weeks) are more vulnerable to cryogenic/measuring system problems than the cable testing which takes place on a "daily" cycle.

Cost issues remain the biggest challenge (as usual). The lack of continuity in overall HEP funding does not help this in this regard.